A STUDY OF THE MACROINVERTEBRATE DRIFT IN THE DES MOINES RIVER

An abstract of a Thesis by
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The problem. To determine the effects of Red Rock Dam on one segment of the aquatic fauna, the "drifting" macroinvertebrates.

Procedure. Drift samples were taken at two points on the Des Moines River. One sampling station was located above Red Rock Reservoir and one below. Samples were taken every other week at each station, on two consecutive nights, from August 7, 1973, through November 1, 1973, and April 3, 1974, through May 28, 1974. All sampling periods began at sunset, and ended one hour later. Samples were taken in a Wildco, 33 cm X 48 cm, 491 micron mesh drift net.

Findings. Thirty-one taxa were sampled above the reservoir, while twenty-three were sampled below the reservoir. Total number of organisms per cubic meter were calculated. A decrease in the total number per cubic meter was observed below the dam. The control station had 16.7 times more organisms per cubic meter. The only taxa that were more numerous below the reservoir were the filter-feeding Trichoptera, _Hydropsyche_, and _Cheumatopsyche_. This is apparently a result of the washout of detritus and lentic zooplankton, such as _Leptodora_, from the reservoir. A positive correlation between numbers in the drift and volume was noted, except as a result of major variations caused by life cycle stages of an individual taxon.

Conclusions. The total number of organisms and the number of different species of drifting macroinvertebrates in the Des Moines River was reduced downstream from Red Rock Dam.

Recommendations. The following three topics are proposed extensions of this study:

1) A study of the diurnal variation of drift in the Des Moines River.

2) A study of the transverse variation of the drift across the Des Moines River.

3) A comparison of the phytoplankton and zooplankton above and below Red Rock Reservoir.

A STUDY OF THE MACROINVERTEBRATE DRIFT IN THE DES MOINES RIVER

A Thesis

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by

Craig Eber Parker

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IN THE DES MOINES RIVER

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INTRODUCTION

Increased utilization of watershed areas for farming, housing, and recreation has led to increased problems caused by flooding and drought in these same areas. The U.S. Army Corps of Engineers has attempted to control some of these problems through watershed management. Their effort to control the Des Moines River watershed has led to the construction of Red Rock Dam and the nearly-completed Saylorville Dam.

The construction and operation of these dams and related reservoirs would be expected to alter the aquatic habitat of the Des Moines River. It is further expected that any habitat changes would eventually result in related changes of the aquatic fauna in the affected areas. The objective of this study, therefore, was to determine the effects of Red Rock Dam on one segment of the aquatic fauna, the "drifting" macroinvertebrates.

Drifting aquatic organisms were first observed and recorded by Needham (1928). He collected terrestrial and aquatic organisms in a net stretched across a small stream. These organisms were observed to be "drifting" with the current.

Moffett (1936) thought drift was a result of physical disturbances, such as floods, which sometimes had catastrophic results on populations. He further observed re-population of denuded areas being initiated by drifting organisms.

Denham (1939) stated that continuous drift of organisms was a natural phenomenon. He observed that increases in populations led to overcrowding, which resulted in increased drift. This theory of increased numbers resulting in increased drift was also supported by the findings of Ide (1942).

After these studies had established "drift" as a natural phenomenon in running waters, many attempts were made to study and delineate the causes and results of drift. Brindle (1958) observed an increased number of organisms in the drift preceding and during emergence of adult aquatic insects. Ambuhl (1959) found that variation in water velocity caused a change in the benthic fauna, which in turn changed the organisms present in the drift. Tanaka (1960) reported a positive correlation between light intensity and daily changes in drift.

A summary of factors that affect drift was published by Waters (1961). These factors were: species present, season of the year, time of day, bottom structure, temperature, light, and turbidity. Other authors added to this list of factors which affect drift. Pearson and Franklin (1968) found that carrying capacity, dissolved oxygen content, water level, and flow were important factors. Waters (1969a) stated that the stage in a life cycle and the growth rate of the organisms also affected drift.

In a review of the literature about insect drift, Waters (1972) listed three basic types of drift: (1) Catastrophic drift - the abrupt displacement or physical disturbance of the bottom fauna due to such extrinsic factors as floods, drought, high temperature, anchor ice, pollution, insecticides, and similar disturbances; (2) Constant drift - the continuous displacement of representatives of all species in low numbers at all times; and (3) Behavioral drift - the drift occurring at night or at some other definite period of time resulting from the behavioral patterns of organisms.

Waters (1962) and Mueller (1963) independently studied the diel periodicity characteristics of *Baetis* and *Gammarus* and observed an increase in the drift of these organisms shortly after sundown. Elliott (1965a) observed that most species that exhibit diel periodicity were night active. Some representative aquatic organisms that have been observed to be night active are *Baetis*, *Simulium*, *Rhyacophila*, Polycentropidae, and Plecoptera (Elliott, 1965b); Coleoptera (Brusven, 1970); *Cheumatopsyche*, *Hydropsyche simulan*, and *Ichytrichia clavata* (Cloud and Stewart, 1974a). Harker (1953) observed that increased activity of mayflies after darkness resulted in increased drift.

Other activity patterns have been reported including day active organisms such as Caddisflies (Anderson, 1966; Waters, 1968; Elliott, 1971), Hydracarina (Bishop and Hynes, 1969), and Hydrachnellae (Elliott and Minshall, 1968). Two diurnal patterns of drifting were observed by Mueller (1965): the bigeminus pattern, in which the major peak of activity occurred at dusk, and the alternans pattern, which included a small peak at dusk, with a larger peak just prior to dawn. There are other groups, such as Chironomidae which do not have any drifting periodicity (Anderson, 1966; Anderson, 1967; Elliott, 1967b). However, Mundie (1971) stated that some chironomids do show diel periodicity.

Endogenously controlled activity is another factor affecting drift of invertebrates. Hartland-Rowe (1955) demonstrated endogenous control of activity in which *Povilla adusta* remained in burrows during the day and emerged at night. This rhythm persisted even in continuous darkness thus demonstrating some intrinsic control. Holt and Waters (1967) stated that endogenously controlled activity may be present in invertebrates, but that it is strongly influenced by environmental factors such as light. Chaston (1968; 1969b) observed that the first peaks in drift were light controlled, but that later peaks were controlled by endogenous activity.

Other factors that affect the activity of organisms also affect drift rates. For example, a particular life-cycle stage may be more apt to appear in the drift. Logan (1963) associated pupation and emergence with increased drift. Macan (1957) associated the later stages of development in Ephemeroptera with increased activity and drift. Increased activity in later stages of the life cycle was related to increased drift by Elliott (1967b), Mueller (1970), Otto (1971), and Reissen and Fox (1970).

Density of organisms may affect drift. Logan (1963) stated that drift density was related initially to growth rates and later to life cycle stages. Denham (1939) felt that increased population sizes which exceeded carrying capacity caused increases in drift. Macan and Mackreth (1957) observed that crowding of specimens caused jostling and resulted in some individuals being pushed into the current and washed away. Reissen and Prins (1970) stated that Ephemerella showed density-dependent drift. Elliott (1967a,b) and Hynes (1968) stated that this increased drift acts as a relief for overpopulated areas and serves as an effective mechanism for colonization of unused micro-habitats. Waters (1961) stated that drift rates serve as a good basis for ranking productivity of an area.

McLay (1968) stated that the organisms appearing in the drift were very similar to benthic populations with some minor differences which could be accounted for because of species behavior. Similar observations were made by Radford and Hartland-Rowe (1971) and Elliott (1973).

Early drift studies estimated large quantities of organisms moving downstream (Berner, 1951). To explain these numbers of drifting organisms, without resultant depopulation of upstream areas, Mueller (1954) postulated a "colonization cycle" in which organisms drifted downstream, filling all available habitats, but on emergence flew in an upstream direction to oviposit. Recent studies by Elliott (1965b), Bishop and Hynes (1969), and Hynes (1970) have estimated that the number of organisms in the drift account for only a small proportion of the total benthic population (.0002-.5%).

Drift has been observed to be correlated with season of year. Waters (1966) observed that drift was most prevalent in summer. Larimore (1972) observed drift to increase through spring into summer, with a gradual decline in the fall to a very low level in the winter. Lehmkuhl and Anderson (1972) stated that season-related drift is a species-specific phenomenon which is dependent on individual life cycles. Cloud and Stewart (1974a,b) noted highest drift rates in the summer months during periods of maximum growth, pupation and emergence.

Tanaka (1960) reported a relationship between light intensity and daily changes in drift and suggested a controlling threshold in the area of one lux for the mayfly, Baetis. Elliott (1965a) concluded that drift virtually ceased when light was applied to a natural stream. Elliott (1967a) later suggested that decreased light caused a decrease in the negative phototaxis of organisms which resulted in an increase in drift. Hughes (1966a) observed that a reduction in light intensity caused a loss of orientation in <u>Baetis</u>. He proposed that this could contribute to increased drift.

Hughes (1966b) observed positive skolotaxis, or directional response to low light intensity, in mayfly nymphs. Mueller (1965; 1966) observed that light intensity works as an on-off triggering device. The amount of light that caused the off effect was between one and five lux as measured at the water's surface. Mueller further observed that continuous light eliminated all rhythmic responses. Holt and Waters (1967) calculated that light at about one lux was effective in depressing drift. Chaston (1969a) observed that light intensities of one to five lux were effective in curtailing drift. Bishop (1969) measured the effects of light on drift and calculated that light of 10^{-3} to 10^{-2} lux was sufficient to curtail drift. He also experimented with colored light and found that it had no significant influence.

Anderson (1966) reported that bright moonlight suppressed the activity of larger size classes of larval insects through negative phototaxis. A similar observation was made by Bishop and Hynes (1969); however, Chaston (1969a) measured no effects of moonlight on drift.

Increased water temperatures were associated with increased drift by Schwarz (1967;1970), Meijering (1972), and Wojtalik and Waters (1970). It was reasoned (see p. 5) that increased temperatures resulted in greater activity of organisms, increasing liability to drift.

Drift rates have been related to water velocity since a study published by Maciolek and Needham (1952). They stated that as flow increased there was a distinct increase in drift. These findings have been substantiated by studies of Logan (1963), Elliott (1967a), Anderson and Lehmkuhl (1968), Bishop and Hynes (1969), Elliott (1971), and Clifford (1972).

As the flow rate stabilized after a period of increased flow, drift was reduced. This may be a result of decreased populations as observed by Hynes (1968), McLay (1968), and Hynes (1970).

When flow decreases, increased drift has been observed. This increase in drift has been attributed to movements to facilitate respiration. This is supported by the findings of Hughes (1966a), Elliott (1967a), Madsen (1968), Minshall and Winger (1968), Hughes (1970), Radford and Hartland-Rowe (1971) and Kroger (1973).

Several authors have observed changes in the drift below impoundments. The presence of lentic organisms downstream from impoundment outlets was observed by Swanson (1967) and Morris et al. (1968). Loss of species as a result of temperature variations was noted by Pearson et al. (1968). Reduction in the number of species and total numbers below an outfall was noted by Hilsenhoff (1971) and

Lehmkuhl (1972). Increased numbers of Trichoptera, such as *Hydropsyche*, and *Cheumatopsyche* was observed by Cushing (1963). An increase in *Baetis*, *Caenis*, chironomids, Simuliidae and *Stenonema*, below a reservoir, was noted by Spence and Hynes (1971). A change in the composition of the drift and increased total weight of drift available for fish food was noted by Larimore (1972).

MATERIALS AND METHODS

Two sampling sites were chosen on the Des Moines River. The control station was located at the southeast edge of the City of Des Moines, Iowa, below the bridge on State Route 46 near the Iowa Power and Light Company's steam generating station. For convenience this station was called IPALCO. The experimental station was located thirty river miles downstream from the Red Rock Dam, near Bussey, Iowa. For convenience this station was called Bussey. These sampling stations can be visualized using the map in Figure 1.

Drift samples were taken every two weeks at each station, on consecutive evenings, for example August 7, 1973, at IPALCO, and August 8, 1973, at Bussey. Samples were taken from August 7, 1973, through November 1, 1973, and from April 3, 1974, through May 28, 1974. No samples were taken during the week of October 1, 1973, because of flood conditions.

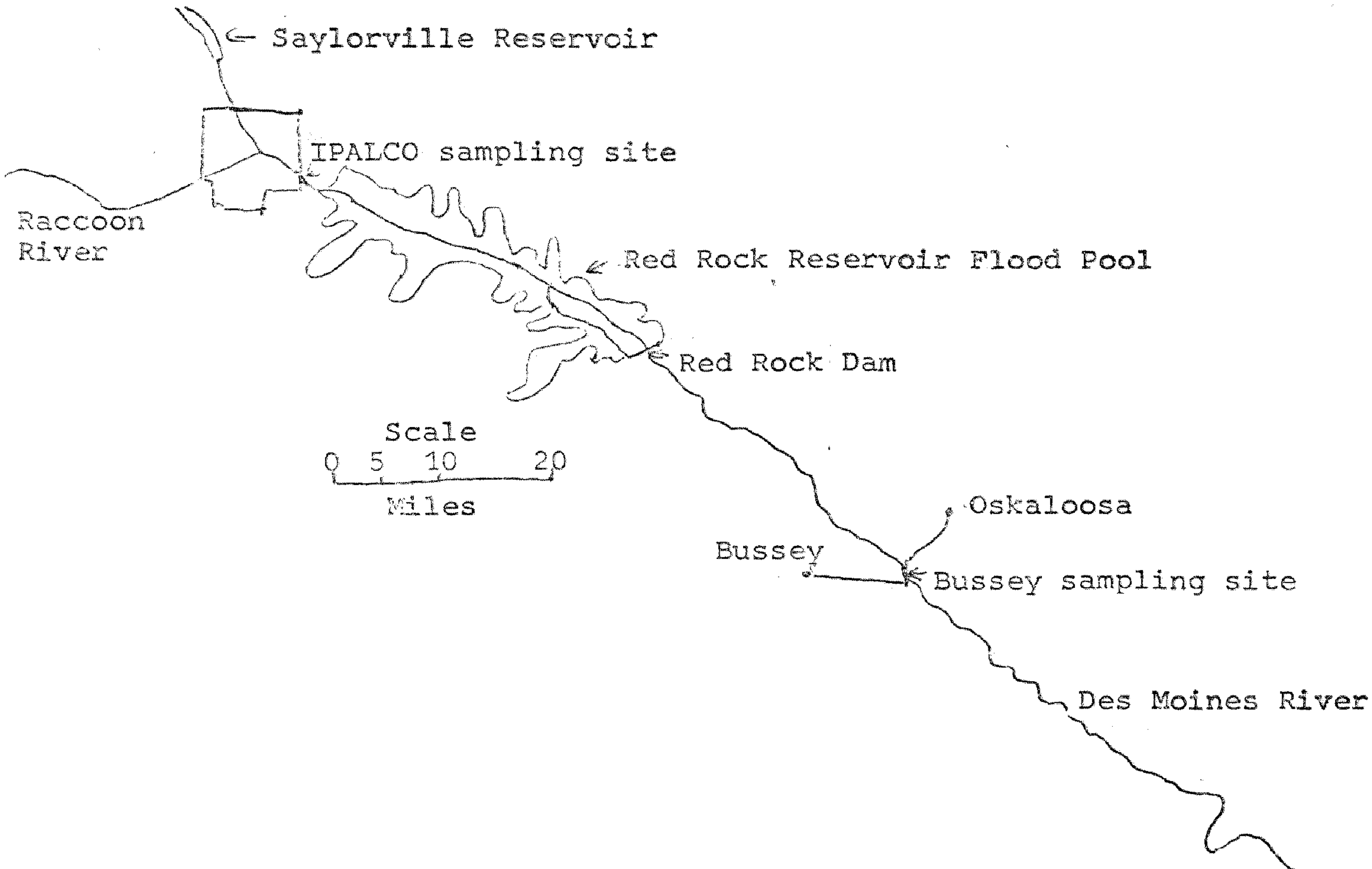

Figure 1. Map of the study area showing the IPALCO and Bussey sampling sites.

All samples were collected in a Wildco #15 stream drift net made of #491 nitex aperature mesh. This conical net had an intake opening of 33 cm by 48 cm, and was approximately one meter long (Figure 2). Samples were taken for one hour beginning at astronomical sunset by placing the net directly into the current 10 cm below the water's surface.

The sample was rinsed into a large plastic wash tub and then poured into a U.S. #30 standard series sieve bucket. The material remaining in the sieve bucket was placed in quart jars and preserved with 95% ethyl alcohol, labeled, and returned to the laboratory.

During the hour of sampling, triplicate velocity readings were taken with a Gurley-Teledyne flow meter. The mean value of these measurements was calculated, and recorded so that water volume passing through the net could be calculated.

The final volume of a particular sample was calculated by the use of the following equations:

Velocity (ft/sec) X Time (sec/hr) X 1.5 Sq. Ft. Surface X 1 hr. Sampling Time = Ft^3

$$Ft^3 \times 2.832 \times 10^{-1} = \text{Liters}$$

Samples taken between August 7, 1973, and September 19, 1973, were taken by placing a drift net 10 cm below the water's surface on a ladder-like apparatus, which had been driven into the river bottom (Figure 3).

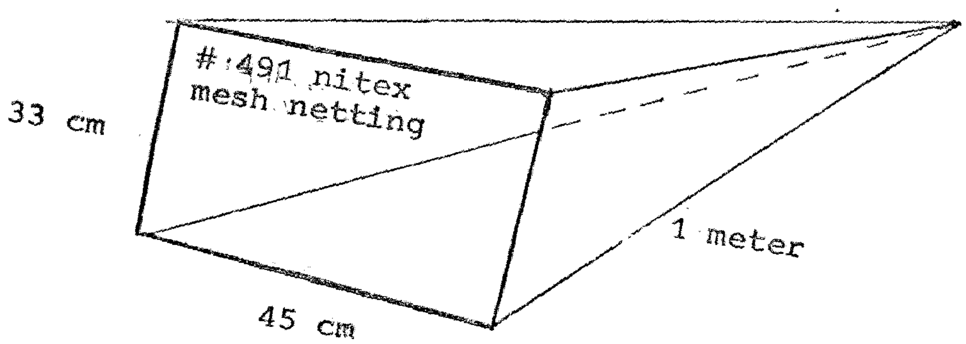

Figure 2. A diagram of the sampling net used in collection of drift samples.

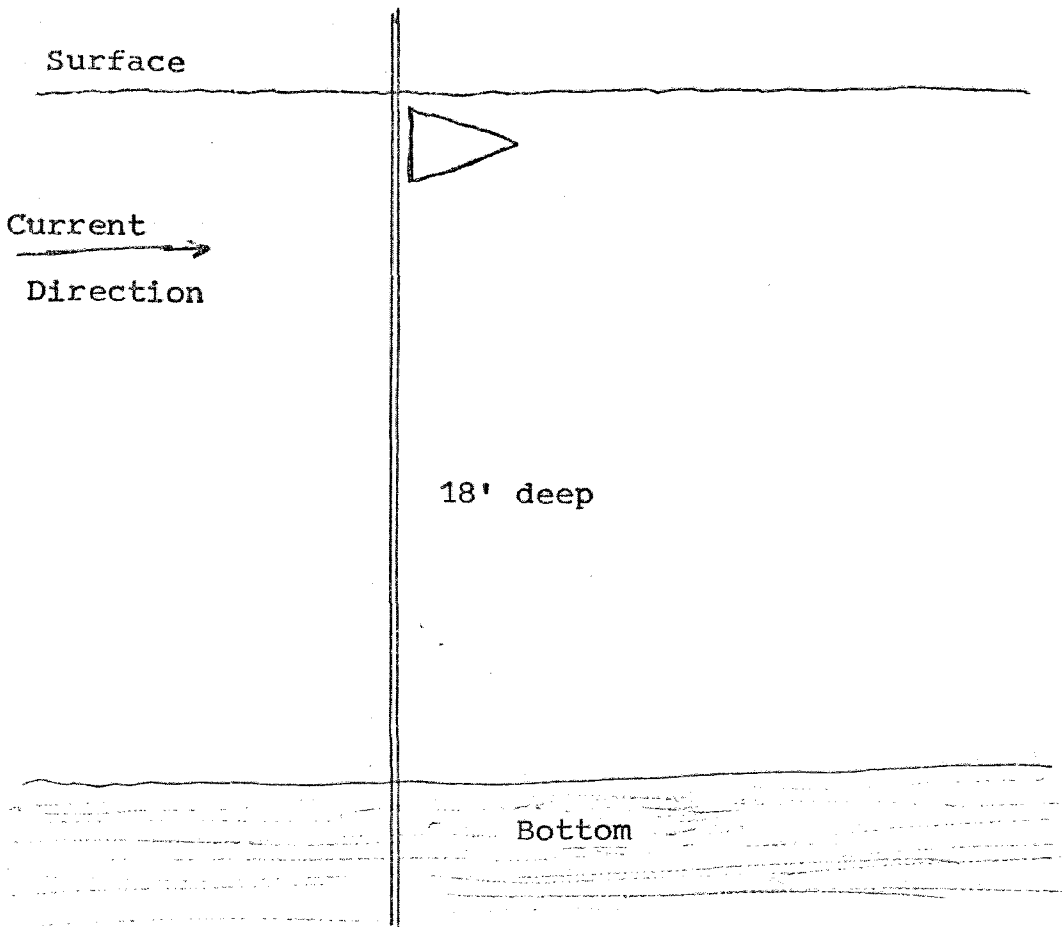

Figure 3. A diagram of the sampling structure used to collect drift samples from August 7, 1973, through September 9, 1973.

Samples taken from October 17, 1973, through November 1, 1973, and April 3, 1974, through May 28, 1974, were taken by placing the drift net 10 cm below the water's surface on a ladder-like apparatus, suspended from the bow of the boat (Figure 4).

To facilitate microscopic sorting, all samples were stained with Phloxine B according to the procedure outlined by Mason and Yevich (1967). The stain was made by mixing 100 mg of Phloxine B with 1 liter of 95% ethyl alcohol. Stain was poured over the sample and allowed to remain for 96 hours. The stain was then decanted and the sample again preserved in 95% ethyl alcohol.

Organisms were separated from the debris by a flotation technique described by Anderson (1959). The alcohol preservative was removed and the sample was placed in a flat enamel pan. Zinc sulfate solution with a specific gravity of 1.2 was poured over the sample. All organisms that floated to the surface were decanted. The sample was then agitated, and any material that floated was removed. This procedure was repeated until no material floated to the surface. All decanted material was placed in a jar, appropriately labeled, and preserved for later microscopic identification and enumeration.

All non-floating material was then subsampled using a sample divider described by Waters (1969b). This subsampler (see Figure 5) was constructed such that material

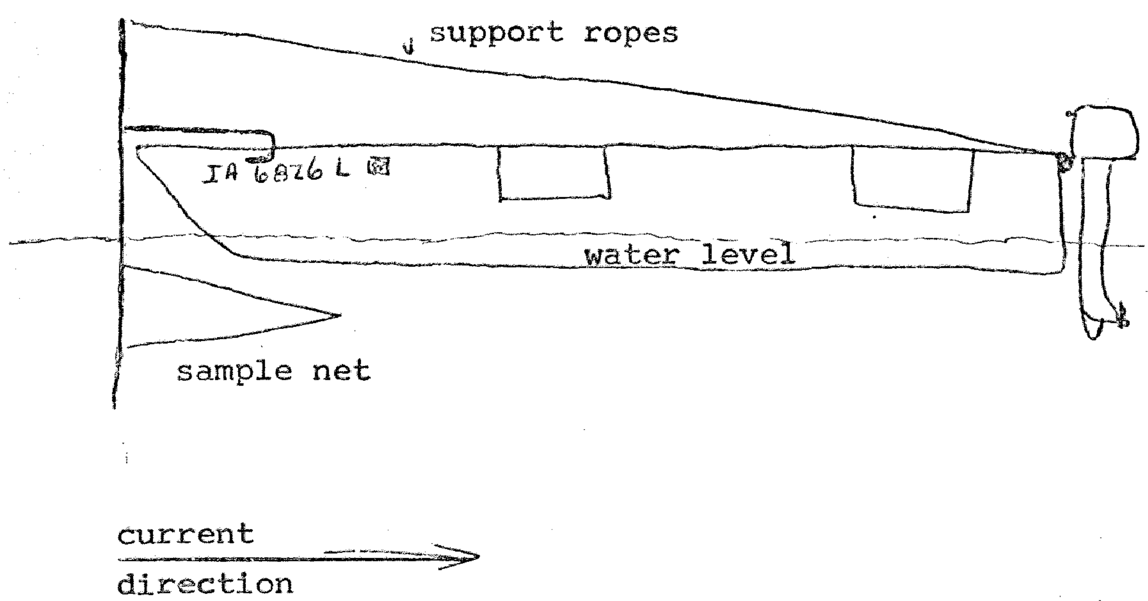

Figure 4. A diagram of the sampling apparatus used to take drift samples from October 17, 1973, through November 1, 1973, and April 3, 1974 through May 28, 1974.

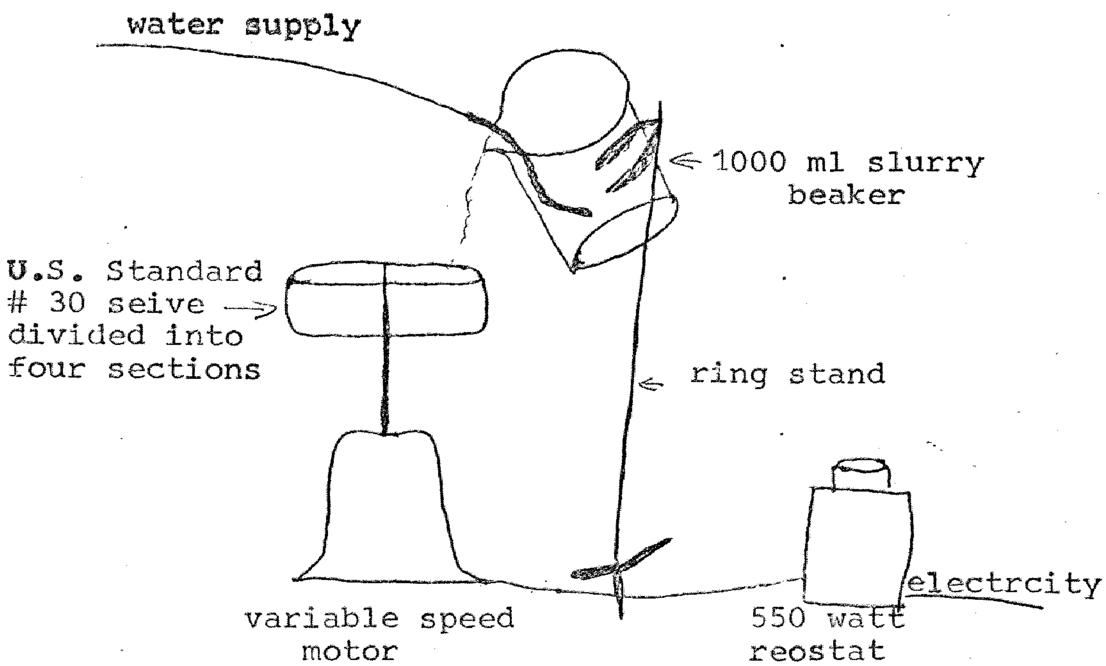

Figure 5. A diagram of the debris subsampler made following the description in Waters (1969c).

was placed into a 1000 ml beaker, and made into a "slurry" using running water. This slurry was allowed to run through a revolving sieve which had been partitioned into four quadrants. The sieve revolved at one revolution per second. The end result was a division of the debris into four fractions. One of these fractions was saved, labeled as a ¼ sub-sample, and preserved for final microscopic identification and enumeration.

All macroinvertebrates in the float and sub-sample were separated from extraneous material and identified using an Olympus model SZ 7-60x dissecting stereoscope. Macroinvertebrates were identified to the most accurate taxonomic level possible using keys constructed by Ross (1944), Burks (1953), and Usinger (1956). All organisms were placed in 2 dram vials, preserved with 5% formalin, and labeled with the appropriate sampling data.

The final estimated number of organisms in a particular sample was calculated by adding the number in the float to four times the number in the sub-sample. That is: "Float" + 4x "Sub-Sample" = Estimated total.

RESULTS

Table 1 summarizes and compares the taxa identified in drift samples taken at the IPALCO and Bussey sampling stations. A total of 31 taxa were found at IPALCO, while 23 taxa were found in Bussey samples.

Table 1. Taxa identified in drift samples taken at the IPALCO and Bussey sampling stations, August 7, 1973, through November 1, 1973, and April 3, 1974 through May 28, 1974.

Taxa	IPALCO	Bussey
Annelida	Yes	Yes
Amphipoda	Yes	Yes
Hydracarina	Yes	No
Collembola	Yes	Yes
Ephemeroptera		
Caenis	Yes	Yes
Baetis	Yes	Yes
Stenonema	Yes	Yes
Cloeon	Yes	No
Isonychia	Yes	Yes
Adults	Yes	Yes
Odonata	Yes	No
Plecoptera		
Isoperla	Yes	Yes
Perolesta	Yes	No
Trichoptera		
Psychomyiid	Yes	No
Cheumatopsyche	Yes	Yes
Hydropsyche frisoni	Yes	Yes
Hydropsyche orris	Yes	Yes
Potamyia flava	Yes	Yes
Mayatrichia	Yes	No
Leptocella candida	Yes	Yes
Adults & Pupae	Yes	Yes
Coleoptera		
Haliplidae	Yes	Yes
Psephenidae	Yes	No
Elmidae	Yes	Yes
Larvae Unidentified	Yes	Yes
Diptera		
Chaoborus	Yes	Yes
Simuliidae	Yes	Yes
Chironomidae	Yes	Yes
Empidae	Yes	Yes
Larvae Unidentified	Yes	No
Adults & Pupae	Yes	Yes
Total number of taxa	31	23

Table 2 presents the estimated total number of benthic taxa collected in drift samples taken at the IPALCO and Bussey sampling stations. The mean and range of values are presented at the bottom of the table. In eight of eleven samples, IPALCO had more taxa than the Bussey station. IPALCO had a mean value of 1.2 times more taxa in each sample than Bussey.

Tables 3 and 4 list the total number of specimens collected, average number of specimens collected, total number of samples in which a specimen was found, and percent of samples in which a specimen was found. At IPALCO the most numerous organisms were Chironomidae, diptera pupae and emergent adults, Annelida, Hydracarina, and *Potamyia flava*, respectively. At Bussey, the most numerous organisms were *Hydropsyche orris*, Trichoptera pupae and emergent adults, diptera pupae and emergent adults, Chironomidae, and *Cheumatopsyche*, respectively.

At IPALCO, two taxa were present in all of the samples. These were Chironomidae, and diptera pupae and adults. At Bussey four taxa were present in all samples. These taxa were *Stenonema*, *Hydropsyche orris*, Chironomidae, and diptera pupae and adults.

At IPALCO six taxa were present in 80-90% of the samples. These taxa were Annelida, Hydracarina, *Stenonema*, *Isonychia*, *Hydropsyche orris*, and *Potamyia flava*. At Bussey two taxa were present in 80-90% of the samples.

Table 2. Estimated total number of benthic taxa, highest, mean, and lowest values recorded from drift samples taken at IPALCO and Bussey sampling stations.

Sampling Dates	IPALCO	Bussey
Aug. 7-8, 1973	16	12
Aug. 21-22, 1973	10	12
Sept. 5-7, 1973	10	8
Sept. 18-19, 1973	8	8
Oct. 17-18, 1973	11	10
Oct. 31-Nov. 1, 1973	13	9
Apr. 3-5, 1974	14	12
Apr. 17-18, 1974	13	7
Apr. 30-May 1, 1974	16	15
May 14-15, 1974	15	13
May 27-28, 1974	7	8
Highest	16	15
Mean	12.1	10.4
Lowest	7	7

Table 3. Total number of specimens, average number of specimens, total number of samples in which a specimen was found, and percent of samples in which a specimen was found, for each taxon collected in drift samples taken at the IPALCO sampling site.

Taxa	Total number	Mean number	Number of samples	Percent of samples
Annelida	528	48.0	11	90.9
Amphipoda	29	2.6	5	45.5
Hydracarina	443	40.3	10	90.0
Collembola	4	0.7	3	27.3
Ephemeroptera				
Caenis	87	7.9	5	45.5
Baetis	11	1.0	5	45.5
Stenonema	67	6.1	10	90.0
Cloeon	1	0.1	1	9.1
Isonychia	42	3.8	9	81.8
Adults	1	0.1	1	9.1
Odonata	1	0.1	1	9.1
Plecoptera				
Isoperla	1	0.1	1	9.1
Perolesta	1	0.1	1	9.1
Trichoptera				
Psychomyiid	10	0.9	1	9.1
Cheumatopsyche	17	1.6	6	54.6
Hydropsyche frisoni	2	0.2	2	18.2
Hydropsyche orris	63	5.7	9	81.8
Potamyia flava	155	14.7	10	90.9
Mayatrichia	4	0.4	1	9.1
Leptocella candida	23	2.1	4	36.4
Adults & Pupae	10	0.9	2	18.2
Coleoptera				
Haliplidae	7	0.6	1	9.1
Psephenidae	6	0.6	1	9.1
Elmidae	4	0.4	2	18.2
Larvae Unidentified	1	0.1	1	9.1
Diptera				
Chaoborus	1	0.1	1	9.1
Simuliidae	23	2.1	3	27.3
Chironomidae	17,096	1,554.2	11	100.0
Empidae	13	1.2	5	45.5
Larvae Unidentified	8	0.7	1	9.1
Adults & Pupae	2,349	213.6	11	100.0

Table 4. Total number of specimens, average number of specimens, total number of samples in which a specimen was found, and percent of samples in which a specimen was found, for each taxon collected in drift samples taken at the Bussey sampling site.

Taxa	Total number	Mean number	Number of samples	Percent of samples
Annelida	8	0.7	3	27.3
Amphipoda	20	1.8	4	36.4
Collembola	6	0.6	4	36.4
Ephemeroptera				
Caenis	7	0.6	4	36.4
Baetis	12	1.1	4	36.4
Stenonema	36	3.3	11	100.0
Isonychia	7	0.6	4	36.4
Adults	8	0.7	2	18.2
Plecoptera				
Isoperla	80	7.3	1	9.1
Trichoptera				
Cheumatopsyche	107	9.7	9	81.8
Hydropsyche frisoni	1	0.1	1	9.1
Hydropsyche orris	1044	94.9	11	100.0
Potamyia flava	101	9.2	9	81.8
Leptocella candida	7	0.6	4	36.4
Adults & Pupae	370	33.6	5	45.5
Coleoptera				
Haliplidae	3	0.3	1	9.1
Elmidae	2	0.2	1	9.1
Larvae Unidentified	1	0.1	1	9.1
Diptera				
Chaoborus	3	0.3	1	9.1
Simuliidae	19	1.7	4	36.4
Chironomidae	168	15.3	11	100.0
Empidae	10	0.9	6	54.5
Adults & Pupae	222	20.2	11	100.0

These taxa were Cheumatopsyche, and Potamyia flava.

At IPALCO, twelve taxa were present in less than 10% of the samples. These taxa were Cloeon, Ephemeroptera adults, Odonata, Isoperla, Perolesta, Psychomyiid, Mayatrichia, Haliplidae, Psephenidae, coleoptera larvae, Chaoborus, and diptera larvae (unidentified). At Bussey, six taxa were present in less than 10% of the samples. These taxa were Isoperla, Hydropsyche frisoni, Haliplidae, Elmidae, and coleoptera larvae (unidentified).

Figures 6, 7, 8, and 9, show the estimated total number of organisms collected in drift samples for some of the more common taxa taken at the IPALCO and Bussey sampling stations.

The total volume of water and estimated total number of organisms captured in each drift sample is presented in Figure 10. The August 7, 1973, IPALCO sample contained the largest number of total organisms: 14,291. Of this number, 12,388 were Chironomidae, and 1,232 were diptera adults and pupae. These groups represented about 95% of the organisms in the sample. With the exception of this sample, the total numbers in the other drift samples tended to follow the flow rate. That is, decreased flow and decreased drift appear to be positively correlated. The same pattern appeared in the Bussey samples, with the exception of the August 22, 1973, sample which appears to have been the result of the relatively large number of emergent Trichoptera.

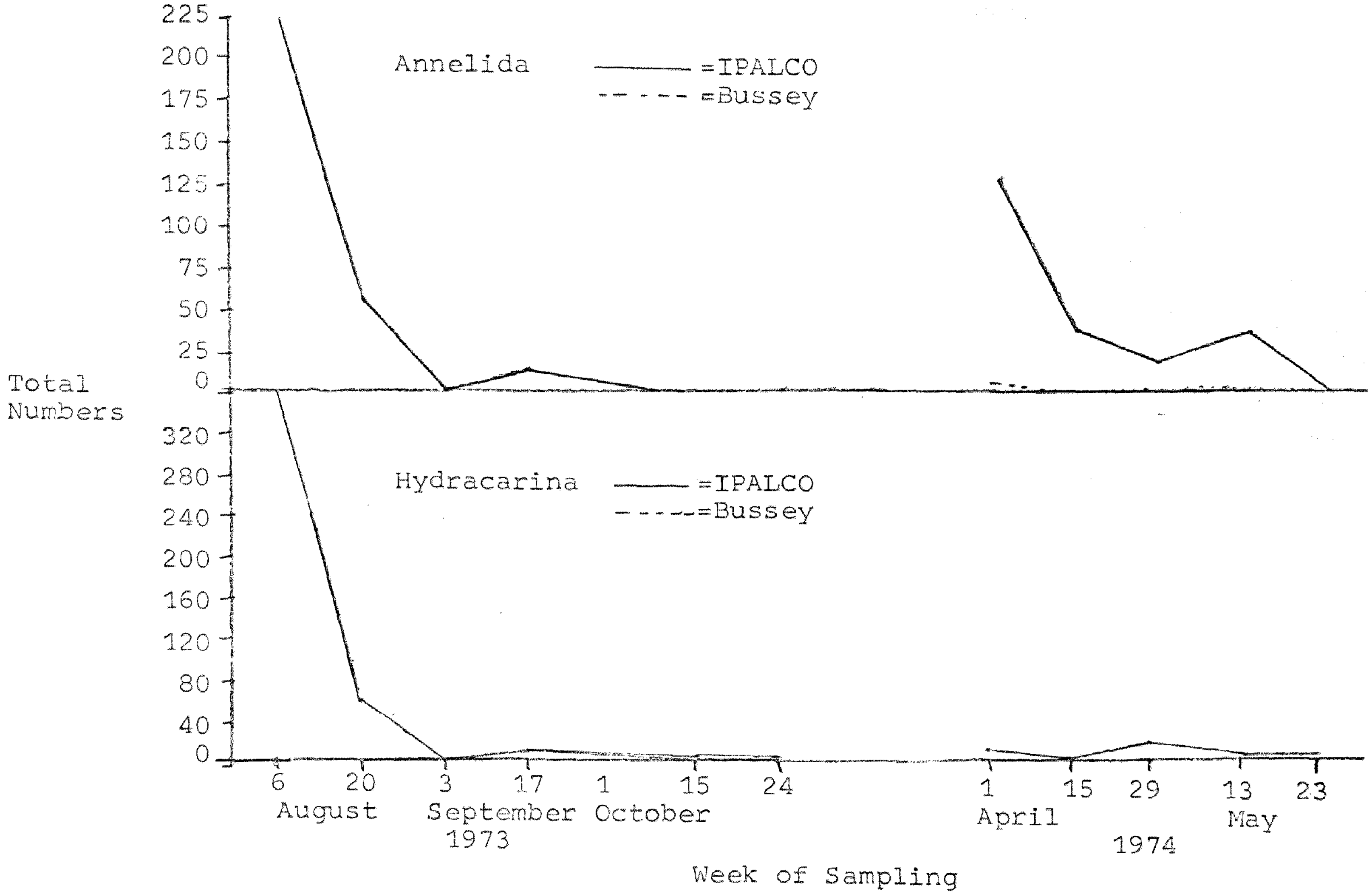

Figure 6. Estimated total number of Annelida and Hydracarina collected in drift samples taken at the IPALCO and Bussey sampling stations.

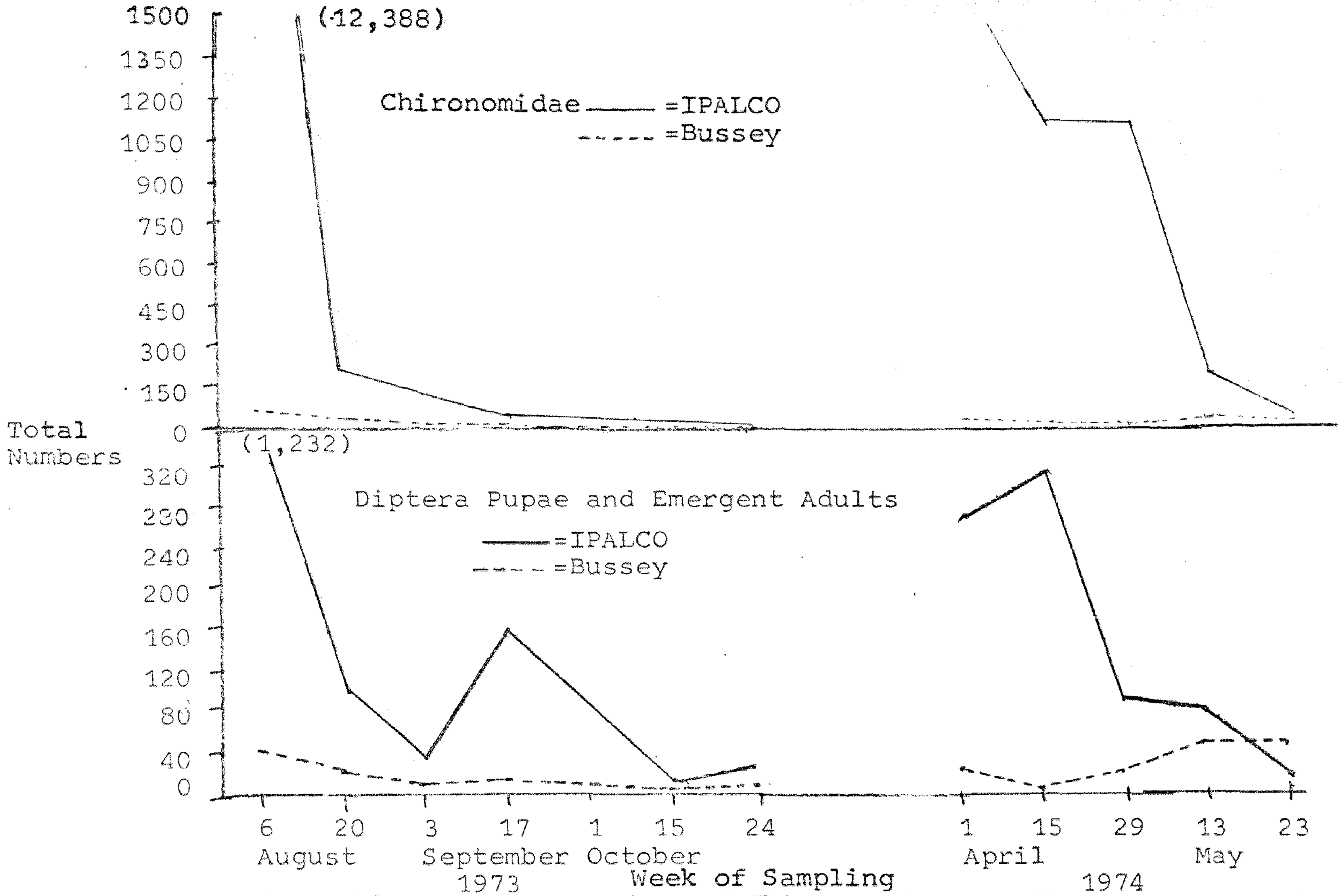

Figure 7. Estimated total number of Chironomidae and diptera pupae and emergent adults, collected in drift samples taken at IPALCO and Bussey sampling stations.

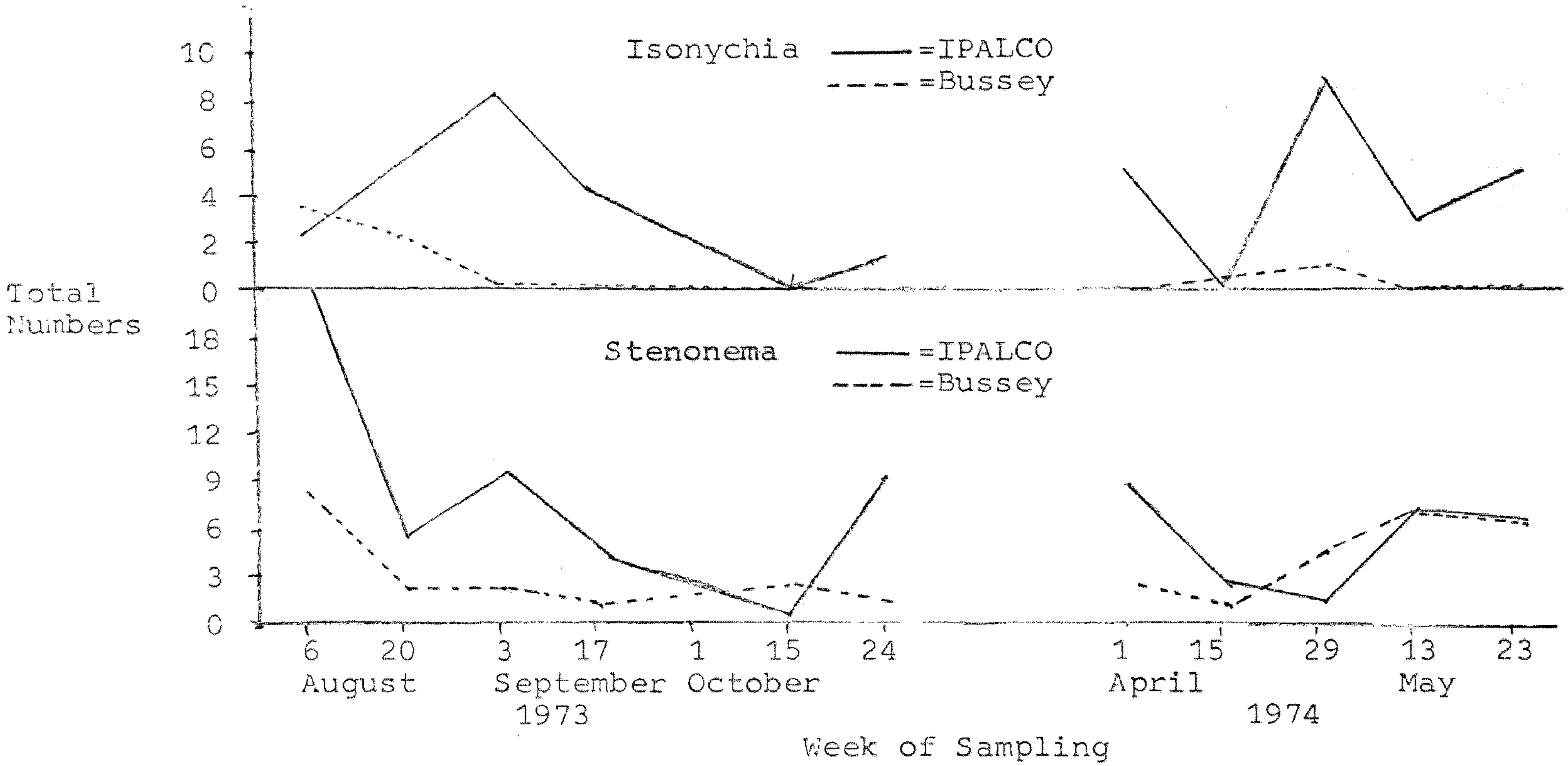

Figure 8. Estimated total number of Isonychia and Stenonema collected in drift samples taken at the IPALCO and Bussey sampling stations.

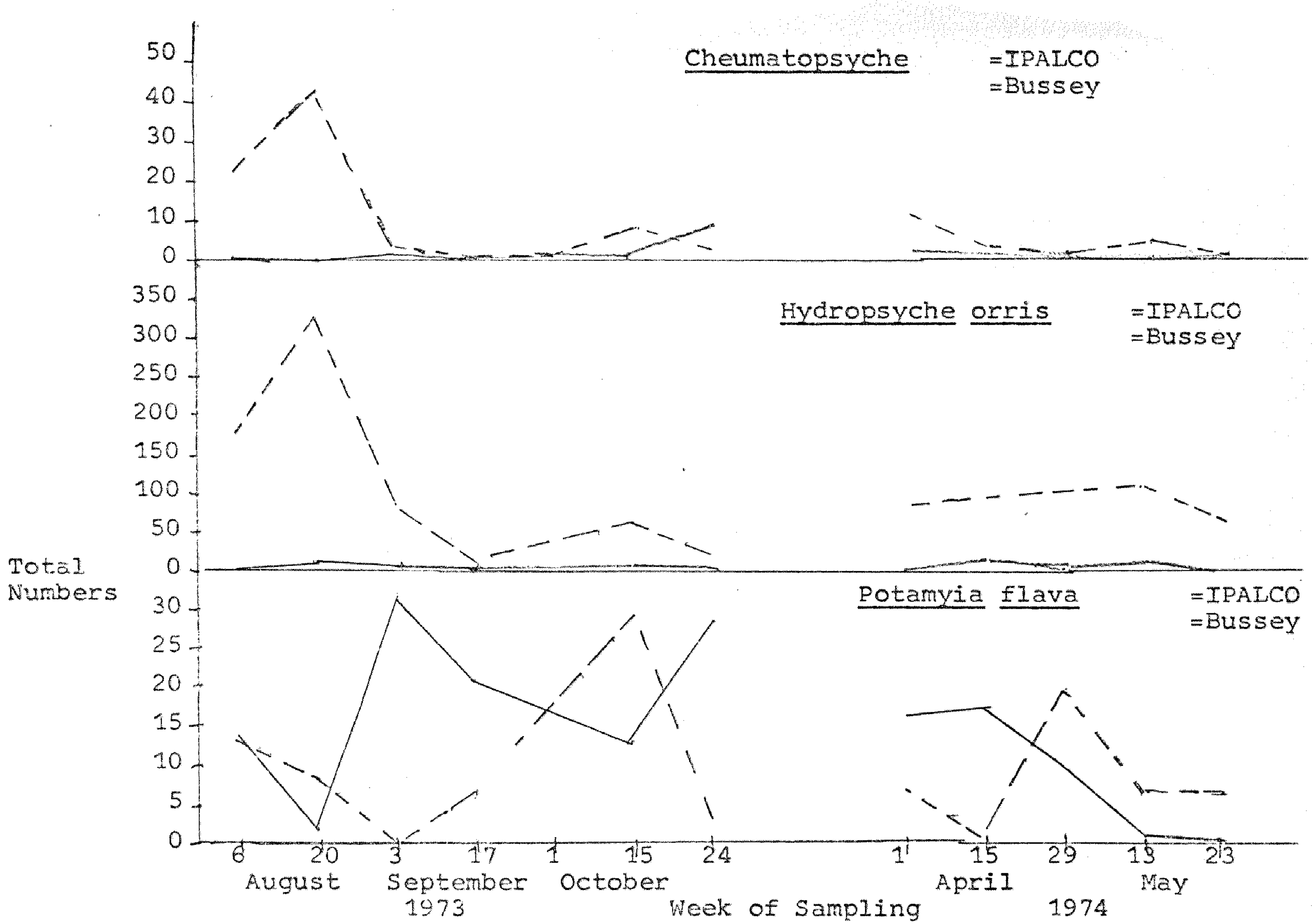

Figure 9. Estimated total number of Cheumatopsyche, Hydropsyche orris, and Potamyia flava, collected in drift samples taken at the IPALCO and Bussey sampling stations.

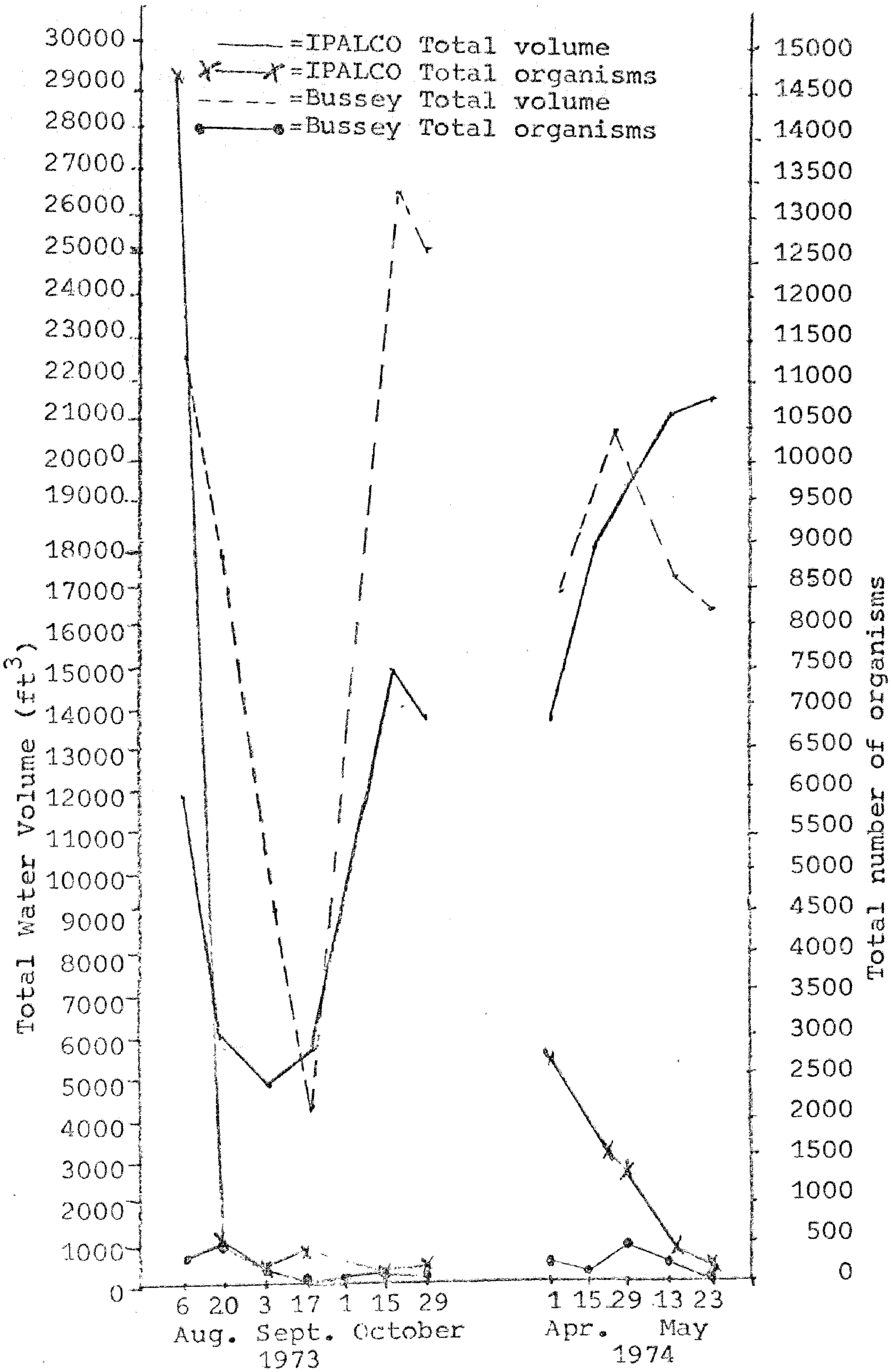

Figure 10. Water volume and estimated total number of organisms collected in drift samples taken at the IPALCO and Bussey sampling stations.

All taxa, except Trichoptera were dramatically reduced after the flood during the week of October 1, 1973. It is important to note that representatives of Trichoptera, *Cheumatopsyche*, *Hydropsyche orris*, and *Potamyia flava* were present in constant or increased numbers after the flood.

Table 5 presents the estimated total number of benthic organisms per cubic meter for the entire sampling period at both IPALCO and Bussey sampling stations. Estimated numbers per cubic meter were higher at IPALCO than Bussey in all samples except the May 27-28, 1974, series. Total numbers at IPALCO ranged from 78.6 times larger than Bussey, to 1.3 times smaller. The mean value for IPALCO samples was 16.7 times larger than the mean at Bussey. This large difference was mainly due to the extreme number of Chironomidae in the August 7, 1973, IPALCO sample and the low number of organisms in the Bussey sample of April 18, 1974.

Table 6 shows the estimated numbers per cubic meter at the IPALCO and Bussey stations with the data from the August 7-8,1973, and April 17-18, 1974, series removed. The total numbers at IPALCO ranged from 15.5 times larger to 1.3 times smaller than Bussey. The mean values show IPALCO to have 4.1 times more organisms than the Bussey samples.

Tables 7 and 8 present the estimated total numbers of benthic organisms per hour, collected in drift samples

Table 5. Estimated total number of organisms per cubic meter (1000 l) collected in drift samples taken at IPALCO and Bussey sampling stations.

Sampling Dates	IPALCO	Bussey
Aug. 7-8, 1973	345.4	5.1
Aug. 21-22, 1973	25.8	9.5
Sept. 5-7, 1973	14.6	8.0
Sept. 18-19, 1973	16.2	3.2
Oct. 17-18, 1973	1.2	1.1
Oct. 31-Nov. 1, 1973	2.4	0.4
April 3-5, 1974	42.6	2.7
April 17-18, 1974	24.4	0.3
April 30-May 1, 1974	19.9	3.6
May 14-15, 1974	5.4	3.8
May 27-28, 1974	1.7	2.2
Highest	345.4	9.5
Mean	45.4	3.6
Lowest	1.2	0.3

Table 6. Estimated total number of organisms per cubic meter (1000 l) collected in drift samples taken at IPALCO and Bussey sampling stations. Data from August 7 and 8, 1973, and April 17 and 18, 1974, have been removed.

Sampling Dates	IPALCO	Bussey
Aug. 21-22, 1973	25.8	9.5
Sept. 5-7, 1973	14.6	8.0
Sept. 18-19, 1973	16.2	3.2
Oct. 17-18, 1973	1.2	1.1
Oct. 31-Nov. 1, 1973	2.4	0.4
April 3-5, 1974	42.6	2.7
April 30-May 1, 1974	19.9	3.6
May 14-15, 1974	5.4	3.8
May 27-28, 1974	1.7	2.2
Highest	25.8	9.5
Mean	14.4	3.8
Lowest	1.2	1.1

Table 7. Estimated total number of benthic organisms collected per hour, in drift samples taken at IPALCO and Bussey sampling stations.

Sampling Dates	IPALCO	Bussey
Aug. 7-8, 1973	14,291	407
Aug. 21-22, 1973	537	584
Sept. 5-7, 1973	250	248
Sept. 18-19, 1973	311	45
Oct. 17-18, 1973	64	102
Oct. 31-Nov. 1, 1973	113	39
April 17-18, 1974	2,054	162
April 30-May 1, 1974	1,523	21
May 14-15, 1974	399	235
May 27-28, 1974	120	132
Highest	14,291	584
Mean	1,910.8	203.9
Lowest	64	21

Table 8. Estimated total number of benthic organisms collected per hour, in drift samples taken at IPALCO and Bussey sampling stations. Data from August 7 and 8, 1973, has been removed.

Sampling Dates	IPALCO	Bussey
Aug. 21-22, 1973	537	584
Sept. 5-7, 1973	250	248
Sept. 18-19, 1973	311	45
Oct. 17-18, 1973	64	102
Oct. 31-Nov. 1, 1973	113	39
April 3-5, 1974	2,054	164
April 17-18, 1974	1,523	21
April 30-May 1, 1974	1,357	268
May 14-15, 1974	399	235
May 27-28, 1974	120	132
Highest	2,054	584
Mean	672.8	183.6
Lowest	64	21

taken at the IPALCO and Bussey sampling stations. Table 7 shows IPALCO samples with larger numbers of organisms than Bussey in eight of eleven sample series. IPALCO samples ranged from 24.5 to 3.1 times larger than Bussey, with a mean value of 9.4 times as many organisms. Table 8 represents all the samples with the exception of the August 7-8, 1973, samples. The adjusted mean values show IPALCO to have 3.7 times more organisms than the Bussey samples.

It should be noted that the removal of the August 7-8, 1973, sample series data decreased the difference between IPALCO and Bussey sampling stations in the total number per cubic meter, and the total number per hour sample, while having little effect on the average number of taxa present in each hour sample.

Although not included in the tabular and graphical presentation in this section, members of the crustacean zooplankton, *Leptodora*, *Daphnia*, and *Bosmina* were observed and counted. These results are found in the appendix.

DISCUSSION

Most studies of drift have been made on streams and small rivers, since they are more easily sampled than larger rivers. In some studies, for instance, the entire cross-section of a small stream has been diverted through a single net (Needham, 1928). Drift studies done on larger streams and rivers must rely on relatively small samples. Although the samples taken in this study did not represent the total drift of the Des Moines River, the two sampling stations should be comparable.

At the station upstream from Red Rock Dam (IPALCO) thirty-one taxa were collected, compared to twenty-three downstream from the dam at Bussey. This decreased number of taxa below an impoundment tends to support similar findings by Hilsenhoff (1971), and Lehmkuhl (1972). Previous studies by McLay (1968), Radford and Hartland-Rowe (1971), and Elliott (1973) have indicated that most of the species present in benthic samples are also found in the drift samples. This information would tend to indicate that there is a somewhat greater diversity of benthic organisms above Red Rock Reservoir.

The effect of the dam is further substantiated by an examination of the predominant groups of organisms found in the drift samples. Of the nine most abundant taxa, all except the two filter-feeding trichopteran species, Cheumatopsyche and Hydropsyche, were more common upstream from the dam. Spence and Hynes (1971), Cushing (1963), and Hilsenhoff (1971) demonstrated that certain groups, including Cheumatopsyche and Hydropsyche were often found in increased numbers below reservoirs because of the outflow of plankton and detritus which serve as food for these organisms. Zooplankton counts, although not included in benthic calculations, clearly demonstrate the washout of the lentic zooplankter, Leptodora, from Red Rock Reservoir.

Pearson et al. (1968) noted that increased flow rates, decreased water temperatures in summer, and increased water temperatures in winter are factors brought about by impoundments which can change the aquatic environment to the point that whole species may be lost from the affected areas. The total lack of Hydracarina, and greatly reduced numbers of Annelida collected in samples below Red Rock Dam tend to support this finding. Decreased numbers of dipteran groups were also observed below the reservoir.

Estimated total number of organisms collected per cubic meter at IPALCO ranged from 78.6 times larger to 1.3 times smaller than at Bussey. Mean values indicate IPALCO samples contain 16.7 times more organisms than Bussey samples. This general decrease in total numbers of organisms below an impoundment supports the findings of Pearson, Kramer, and Franklin (1968), and Lehmkuhl (1972). By re-calculating the estimated total numbers and removing the extreme values from August 7-8, 1973, and April 17-18, 1974, sampling series, the upstream samples still contain 4.1 times as many organisms as the downstream samples.

Estimated total number of organisms collected per hour demonstrate larger numbers at IPALCO. The comparisons between IPALCO and Bussey stations were similar for number per hour and number per cubic meter. That is, both demonstrated a general decrease in the numbers collected below Red Rock Dam.

It is important to note the decrease in numbers per cubic meter in the drift after the flood during the first week in October, 1973. At IPALCO, the number per cubic meter decreased from 16.2 to 1.2, while at Bussey the number decreased from 3.2 to 1.1. In the subsequent sampling set, taken two weeks later, the numbers at IPALCO increased, but a continual decline was observed in the numbers at Bussey. This apparently represents the lag time between the flow variations above and below the reservoir. The presence of the dam reduced the effect of the flood on the fauna, but prolonged the duration of this reduction. This effect of reduced populations, and consequently of drift, as a result of floods is supported by Anderson and Lehmkuhl (1968), and Hynes (1970). Trichoptera were present in constant or increased numbers in drift samples taken after the October 1973 flood. Their case building behavior makes them less likely to drift and be catastrophically reduced. This supports the findings of McLay (1968).

When comparing flow rates, volume, and total number of organisms in each sample, there was a positive correlation between flow and the number of organisms captured. Similar findings were also reported by Anderson and Lehmkuhl (1968), Bishop and Hynes (1969), Clifford (1972), Elliott (1967a and 1971), Logan (1963), and Maciolek and Needham

(1952). This correlation did not hold for the sample of August 7, 1973, at IPALCO, and August 22, 1973, at Bussey, or for all of the spring samples taken at IPALCO. These variations were a result of changes in the drift of certain taxa such as Chironomidae and Hydropsyche orris, and probably reflect stages in their life cycle.

In the August 7, 1973, IPALCO sample there were 14,291 organisms, of which 12,388 were Chironomidae, and 1,232 were diptera pupae and emergent adults. These two taxa account for 95.3% of the sample which is a much larger percentage than was normally found in IPALCO samples. In the August 22, 1973, Bussey sample, there were 584 organisms. Of this number 329 were Hydropsyche orris, and 140 were Trichoptera pupae and emergent adults. These two groups represented 80% of the sample, again an unusually large percentage for that area. During the spring sampling at the IPALCO station, samples showed a reversal of the association between flow and drift. This apparently was due to the decrease in numbers of Chironomidae.

Several authors have attempted to relate changes in drift phenomenon with stages in the life cycle of organisms. Elliott (1967b) stated that organisms are more likely to drift in later stages of their life. Reissen and Fox (1970) and Otto (1971) observed increased drift rates at times of emergence. The changes observed in the Chironomidae and Trichoptera observed in this study may have been a result of the stage of the life cycle of the organisms. Pupation of Chironomidae apparently caused the variation in the drifting numbers at IPALCO on August 7, 1973. Emergence of Trichoptera was observed during the August 22, 1973, Bussey sample, and apparently caused that variation.

SUMMARY AND CONCLUSIONS

Samples were taken at two locations on the Des Moines River to determine the effects of Red Rock Dam on macroinvertebrate drift. Samples were taken at a control station above the Red Rock Reservoir, and at an experimental station located approximately thirty river miles downstream from the dam. Samples were collected in a 33 cm X 48 cm drift net for one hour beginning at sunset. The samples were preserved with alcohol and returned to the laboratory where they were stained with Phloxine B. The majority of the organisms were removed from the debris by flotation with zinc sulfate. The remaining debris was subsampled by dividing it into fourths with one portion being saved for microscopic examination and identification. Estimated total numbers were calculated from combining the counts from the float and the subsample.

The results demonstrated a decrease in the total number of species observed below Red Rock Dam. Thirty-one species were present at the control station, while twenty-three were found at the experimental station. Hydracarina were absent and Annelida were greatly reduced in numbers below the dam. A decrease in the total number per cubic meter was observed below the dam. The control station had 16.7 times more organisms per cubic meter. The only taxa that were more numerous below the reservoir were the filter-feeding Trichoptera, *Hydropsyche*, and *Cheumatopsyche*. This is apparently a result of the washout of detritus and lentic zooplankton, such as *Leptodora*, from the reservoir. A positive correlation between numbers in the drift, and volume was noted, except as a result of major variations caused by life history stages of individual taxon.

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APPENDIX

Table 9. Drift sample data from IPALCO station, Aug. 7, 1973. Volume sampled 11,718 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	31	48	223	1.6
Amphipoda	1	0	1	<0.1
Hydracarina	6	82	334	2.3
Ephemeroptera				
Caenis	17	7	45	0.3
Stenonema	9	3	21	0.2
Cloeon	1	0	1	<0.1
Isonychia	2	0	2	<0.1
Trichoptera				
Psychomyiid	2	2	10	<0.1
Hydropsyche frisoni	1	0	1	<0.1
Hydropsyche orris	3	1	7	<0.1
Potamyia flava	9	1	13	<0.1
Mayatrichia	0	1	4	<0.1
Adults	2	0	2	<0.1
Coleoptera				
Haliplidae	3	1	7	<0.1
Diptera				
Chironomidae	1,408	2,745	12,388	86.7
Adults & Pupae	616	154	1,232	8.6
Total Number	2,111	3,045	14,291	
Total Taxa	15	11	16	
Number/1000 ft^3	1219.6			
Number per M^3	345.3			
Terrestrial Volunteers	1	0	1	

Table 10. Drift sample data from Bussey station, Aug. 8, 1973. Volume sampled 22,464 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Amphipoda	4	3	16	3.9
Ephemeroptera				
Caenis	1	0	1	0.3
Stenonema	4	1	8	2.0
Isonychia	3	0	3	0.7
Trichoptera				
Cheumatopsyche	22	0	22	5.4
H. orris	177	0	177	43.5
Potamyia flava	13	0	13	3.2
Adults & Pupae	52	0	52	12.8
Coleoptera Haliplidae	3	0	3	0.7
Diptera				
Chironomidae	38	8	70	17.2
Empidae	2	0	2	0.5
Adults & Pupae	36	1	40	9.8
Total Number	355	13	407	
Total Taxa	12	4	12	
Number/1000 ft^3	18.1			
Number per M^3	5.1			
Cladocera				
Leptodora	780	122	1,268	
Daphnia	79	7	107	
Terrestrial Volunteers	29	0	29	

Table 11. Drift sample data from IPALCO station, Aug. 21, 1973. Volume sampled 5,886 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	7	11	51	9.5
Hydracarina	21	11	65	12.1
Ephemeroptera				
Caenis	23	1	27	5.0
Stenonema	5	0	5	0.9
Isonychia	5	0	5	0.9
Trichoptera				
H. orris	11	0	11	2.1
Potamyia flava	2	0	2	0.4
Coleoptera				
Elmidae	3	0	3	0.6
Diptera				
Chironomidae	145	29	261	48.6
Adults & Pupae	99	2	107	19.9
Total Number	321	54	537	
Total Taxa	10	5	10	
Number/1000 ft^3	91.2			
Number per M^3	25.8			
Terrestrial Volunteers	35	1	39	

Table 12. Drift sample data from Bussey station, Aug. 22, 1973. Volume sampled 17,496 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Ephemeroptera				
Caenis	3	0	3	0.5
Stenonema	2	0	2	0.3
Isonychia	2	0	2	0.3
Trichoptera				
Cheumatopsyche	42	0	42	7.2
H. frisoni	1	0	1	0.2
H. orris	321	2	329	56.3
Potamyia flava	8	0	8	1.4
Adults & Pupae	140	0	140	24.0
Coleoptera				
Elmidae	2	0	2	0.3
Larvae Unident.	1	0	1	0.2
Diptera				
Chironomidae	18	3	30	5.1
Adults & Pupae	24	0	24	4.1
Total Number	564	5	584	
Total Taxa	12	2	12	
Number/1000 ft^3	33.4			
Number per M^3	9.5			
Cladocera				
Leptodora	2,666	759	5,702	
Daphnia	61	4	77	
Terrestrial Volunteers	61	0	61	

Table 13. Drift sample data from Bussey station, Sept. 5, 1973. Volume sample 9,902 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Ephemeroptera				
Caenis	1	0	1	0.4
Stenonema	2	0	2	0.8
Adults	6	0	6	2.4
Trichoptera				
Cheumatopsyche	3	0	3	1.2
H. orris	81	1	85	34.3
Adults & Pupae	141	0	141	56.9
Diptera				
Chironomidae	5	0	5	2.0
Adults & Pupae	5	0	5	2.0
Total Number	244	1	248	
Total Taxa	8	1	8	
Number/1000 ft^3	28.2			
Number per M^3	8.0			
Cladocera				
Leptodora	33	16	97	
Terrestrial Volunteers	2	0	2	

Table 14. Drift sample data from IPALCO station, Sept. 7, 1973. Volume sampled 4,860 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	1	0	1	0.4
Ephemeroptera				
Stenonema	1	2	9	3.6
Isonychia	4	1	8	3.2
Trichoptera				
Cheumatopsyche	1	0	1	0.4
H. orris	7	1	11	4.4
Potamyia flava	13	5	33	13.2
Leptocella candida	2	2	10	4.0
Diptera				
Chironomidae	13	32	141	56.4
Empidae	0	1	4	1.6
Adults & Pupae	12	5	32	12.8
Total Numbers	54	49	250	
Total Taxa	9	8	10	
Number/1000 ft^3	51.4			
Number per M^3	14.6			
Terrestrial Volunteers	1	0	1	

Table 15. Drift sample data from IPALCO station, Sept. 18, 1973. Volume sampled 5,454 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	1	3	13	4.2
Hydracarina	0	2	8	2.6
Ephemeroptera				
Stenonema	0	1	4	1.3
Isonychia	0	1	4	1.3
Trichoptera				
Potamyia flava	5	4	21	6.8
L. candida	1	1	5	1.6
Diptera				
Chironomidae	25	18	97	31.2
Adults & Pupae	51	27	159	51.1
Total Number	83	57	311	
Total Taxa	5	8	8	
Number/1000 ft^3	57.0			
Number per M^3	16.2			
Terrestrial Volunteers	2	0	2	

Table 16. Drift sample data from Bussey station, Sept. 19, 1973. Volume sampled 3,996 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Ephemeroptera				
Baetis	1	0	1	2.2
Stenonema	1	0	1	2.2
Trichoptera				
H. orris	11	0	11	24.4
Potamyia flava	3	1	7	15.6
Adults & Pupae	6	0	6	13.3
Diptera				
Chironomidae	0	2	8	17.8
Empidae	1	0	1	2.2
Adults & Pupae	6	1	10	22.2
Total Number	29	4	45	
Total Taxa	7	3	8	
Number/1000 ft^3	11.3			
Number per M^3	3.2			
Terrestrial Volunteers	2	0	2	

Table 17. Drift sample data from Bussey station, Oct. 17, 1973. Volume sampled 26,622 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Collembola	1	0	1	1.0
Ephemeroptera				
Baetis	2	0	2	2.0
Stenonema	2	0	2	2.0
Trichoptera				
Cheumatopsyche	8	0	8	7.8
H. orris	48	2	56	54.9
Potamyia flava	21	2	29	28.4
L. candida	1	0	1	1.0
Diptera				
Chaoborus	1	0	1	1.0
Chironomidae	1	0	1	1.0
Adults & Pupae	1	0	1	1.0
Total Number	86	4	102	
Total Taxa	10	2	10	
Number/1000 ft^3	3.8			
Number per M^3	1.1			
Terrestrial Volunteers	14	0	14	

Table 18. Drift sample data from IPALCO station, Oct. 18, 1973. Volume sampled 14,800 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Amphipoda	0	1	4	6.3
Hydracarina	4	0	4	6.3
Ephemeroptera				
Caenis	0	1	4	6.3
Adults	1	0	1	1.6
Plecoptera				
Perolesta	1	0	1	1.6
Trichoptera				
Cheumatopsyche	1	0	1	1.6
H. orris	4	0	4	6.3
Potamyia flava	9	1	13	20.3
Diptera				
Chironomidae	6	1	10	15.6
Larvae Unident.	0	2	8	12.5
Adults & Pupae	6	2	14	21.9
Total Number	32	8	64	
Total Taxa	8	6	11	
Number/1000 ft^3	4.3			
Number per M^3	1.2			
Cladocera				
Daphnia	1	0	1	
Terrestrial Volunteers	6	0	6	

Table 19. Drift sample data from Bussey station, Oct. 31, 1973. Volume sampled 25,056 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Ephemeroptera				
Stenonema	1	0	1	2.
Isonychia	1	0	1	2.
Trichoptera				
Cheumatopsyche	3	0	3	7.
H. orris	16	1	20	51.
Potamyia flava	3	0	3	7.
Diptera				
Simuliidae	1	0	1	2.
Chironomidae	0	1	4	10.
Empidae	1	0	1	2.
Adults & Pupae	5	0	5	12.8
Total Number	31	2	39	
Total Taxa	8	2	9	
Number/1000 ft^3	1.			
Number per M^3	0.4			
Cladocera *Daphnia*	9	1	13	
Terrestrial Volunteers	2	1	6	

Table 20. Drift sample data from IPALCO station, Nov. 1, 1973. Volume sampled 13,446 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	0	1	4	3.5
Hydracarina	1	0	1	0.9
Collembola	1	0	1	0.9
Ephemeroptera				
Baetis	4	0	4	3.5
Stenonema	9	0	9	8.0
Isonychia	1	0	1	0.9
Trichoptera				
Cheumatopsyche	5	1	9	8.0
H. frisoni	1	0	1	0.9
H. orris	3	0	3	2.7
Potamyia flava	24	1	28	24.8
Diptera				
Simuliidae	7	1	11	9.7
Chironomidae	9	1	13	11.5
Adults & Pupae	24	1	28	24.8
Total Number	89	6	113	
Total Taxa	12	6	13	
Number/1000 ft^3	8.4			
Number per M^3	2.4			
Cladocera				
Daphnia	49	1	53	
Bosmina	2	0	2	
Terrestrial Volunteers	7	0	7	

Table 21. Drift sample data from IPALCO station, April 3, 1974. Volume sampled 13,662 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	11	29	127	6.2
Amphipoda	2	2	10	0.5
Hydracarina	3	2	11	0.5
Collembola	1	0	1	0.1
Ephemeroptera				
Stenonema	4	1	8	0.4
Isonychia	1	1	5	0.2
Trichoptera				
Cheumatopsyche	4	0	4	0.2
H. orris	4	0	4	0.2
Potamyia flava	12	1	16	0.8
Coleoptera				
Psephenidae	6	0	6	0.3
Elmidae	1	0	1	0.1
Diptera				
Chironomidae	820	191	1,584	77.1
Empidae	2	1	6	0.3
Adults & Pupae	250	5	270	13.2
Total Number	1,122	233	2.054	
Total Taxa	14	9	14	
Number/1000 ft^3	150.3			
Number per M^3	42.6			
Cladocera				
Daphnia	146	11	190	
Terrestrial Volunteers	5	0	5	

Table 22. Drift sample data from Bussey station, April 5, 1974. Volume sampled 16,740 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	2	1	6	3.7
Amphipoda	2	0	2	1.2
Collembola	3	0	3	1.9
Ephemeroptera				
Baetis	7	0	7	4.3
Stenonema	2	0	2	1.2
Trichoptera				
Cheumatopsyche	11	0	11	6.8
H. orris	69	3	81	50.0
Potamyia flava	7	0	7	4.3
L. candida	1	0	1	0.6
Diptera				
Chironomidae	10	1	14	8.6
Empidae	0	1	4	2.5
Adults & Pupae	24	0	24	14.8
Total Numbers	138	6	162	
Total Taxa	11	4	12	
Number/1000 ft^3	9.7			
Number per M^3	2.7			
Cladocera				
Daphnia	86	0	86	
Terrestrial Volunteers	8	1	12	

Table 23. Drift sample data from IPALCO station, April 17, 1974. Volume sampled 17,712 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	2	8	34	2.2
Amphipoda	2	2	10	0.7
Hydracarina	1	0	1	0.1
Ephemeroptera				
Caenis	2	0	2	0.1
Baetis	2	0	2	0.1
Stenonema	2	0	2	0.1
Trichoptera				
Cheumatopsyche	1	0	1	0.1
H. orris	8	1	12	0.8
Potamyia flava	13	1	17	1.1
L. candida	0	1	4	0.3
Diptera				
Chironomidae	720	101	1,124	73.8
Empidae	1	0	1	0.1
Adults & Pupae	249	16	313	20.6
Total Number	1,003	130	1,523	
Total Taxa	12	7	13	
Number/1000 ft^3	86.0			
Number per M^3	24.4			
Cladocera				
Daphnia	125	18	197	
Terrestrial Volunteers	2	0	2	

Table 24. Drift sample data from Bussey station, April 17, 1974. Volume sampled 18,954 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Ephemeroptera				
Baetis	1	0	1	4.8
Stenonema	1	0	1	4.8
Trichoptera				
Cheumatopsyche	3	0	3	14.3
H. orris	6	1	10	47.6
Diptera				
Chironomidae	2	0	2	9.5
Empidae	1	0	1	4.8
Adults & Pupae	3	0	3	14.3
Total Number	17	1	21	
Total Taxa	7	1	7	
Number/1000 ft^3	1.1			
Number per M^3	0.3			
Cladocera				
Daphnia	4	0	4	
Terrestrial Volunteers	2	0	2	

Table 25. Drift sample data from IPALCO station, April 30, 1974. Volume sampled 19,332 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	1	6	25	1.8
Amphipoda	4	0	4	0.3
Hydracarina	6	2	14	1.0
Ephemeroptera				
Baetis	2	0	2	0.2
Stenonema	1	0	1	0.1
Isonychia	1	2	9	0.7
Odonata	1	0	1	0.1
Trichoptera				
H. orris	3	0	3	0.2
Potamyia flava	6	1	10	0.7
L. candida	0	1	4	0.3
Coleoptera Larvae Unident.	1	0	1	0.1
Diptera				
Chaoborus	1	0	1	0.1
Simuliidae	1	0	1	0.1
Chironomidae	622	142	1,190	87.7
Adults & Pupae	62	7	90	6.6
Total Number	713	161	1,357	
Total Taxa	15	7	16	
Number/1000 ft^3	70.2			
Number per M^3	19.9			
Cladocera *Daphnia*	23	7	51	
Terrestrial Volunteers	17	0	17	

Table 26. Drift sample data from Bussey station, May 1, 1974. Volume sampled 20,953 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	1	0	1	0.4
Amphipoda	1	0	1	0.4
Collembola	1	0	1	0.4
Ephemeroptera				
Stenonema	4	0	4	1.5
Isonychia	1	0	1	0.4
Adults	2	0	2	0.8
Plecoptera				
Isoperla	80	0	80	29.9
Trichoptera				
Cheumatopsyche	11	0	11	4.1
H. orris	93	4	109	40.7
Potamyia flava	20	0	20	7.5
L. candida	2	0	2	0.8
Diptera				
Chaoborus	2	0	2	0.8
Simuliidae	8	0	8	3.0
Chironomidae	8	0	8	
Adults & Pupae	14	1	18	6.7
Total Numbers	248	5	268	
Total Taxa	15	2	15	
Number/1000 ft^3	12.8			
Number per M^3	3.6			
Cladocera				
Daphnia	74	5	94	
Terrestrial Volunteers	16	0	16	

Table 27. Drift sample data from Bussey station, May 14, 1974. Volume sampled 17,334 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	1	0	1	0.4
Collembola	1	0	1	0.4
Ephemeroptera				
Caenis	2	0	2	0.9
Stenonema	7	0	7	3.0
Trichoptera				
Cheumatopsyche	4	0	4	1.7
H. orris	102	1	106	45.1
Potamyia flava	7	0	7	3.0
L. candida	3	0	3	1.2
Adults & Pupae	27	1	31	13.2
Diptera				
Simuliidae	9	0	0	3.8
Chironomidae	18	0	18	7.7
Empidae	1	0	1	0.4
Adults & Pupae	41	1	45	19.2
Total Number	223	3	235	
Total Taxa	13	3	13	
Number/1000 ft^3	13.6			
Number per M^3	3.8			
Cladocera				
Daphnia	92	2	100	
Terrestrial Volunteer	23	0	23	

Table 28. Drift sample data from IPALCO station, May 15, 1974. Volume sampled 21,114 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	1	10	41	10.3
Hydracarina	3	0	3	0.8
Collembola	2	1	6	1.5
Ephemeroptera				
Caenis	9	0	9	2.3
Baetis	2	0	2	0.5
Stenonema	3	1	7	1.8
Isonychia	3	0	3	0.8
Plecoptera				
Isoperla	1	0	1	0.3
Trichoptera				
H. orris	4	1	8	2.0
Potamyia flava	2	0	2	0.5
Adults & Pupae	8	0	8	2.0
Diptera				
Simuliidae	3	2	11	2.8
Chironomidae	106	25	206	51.6
Empidae	5	1	9	2.3
Adults & Pupae	51	8	83	20.8
Total Number	203	49	399	
Total Taxa	15	8	15	
Number/1000 ft^3	18.9			
Number per M^3	5.4			
Cladocera				
Daphnia	102	20	182	
Terrestrial Volunteers	29	1	33	

Table 29. Drift sample data from IPALCO station, May 27, 1974. Volume sampled 20,466 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Annelida	1	2	9	7.5
Hydracarina	1	0	1	0.8
Ephemeroptera				
Stenonema	1	0	1	0.8
Isonychia	1	1	5	4.2
Trichoptera				
Cheumatopsyche	1	0	1	0.8
Diptera				
Chironomidae	18	16	82	68.3
Adults & Pupae	17	1	21	17.5
Total Numbers	40	20	120	
Total Taxa	7	4	7	
Number/1000 ft^3	5.9			
Number per M^3	1.7			
Cladocera				
Daphnia	7	2	15	
Terrestrial Volunteers	12	1	16	

Table 30. Drift sample data from Bussey station, May 28, 1974. Volume sampled 16,740 cubic feet.

Taxa	Number in Float	Number in Sub-Sample	Estimated Total	Percent of Estimated Total
Amphipoda	1	0	1	0.8
Ephemeroptera				
Baetis	2	0	2	1.5
Stenonema	6	0	6	4.6
Trichoptera				
H. orris	52	2	60	45.5
Potamyia flava	7	0	7	5.3
Diptera				
Simuliidae	1	0	1	0.8
Chironomidae	8	0	8	6.1
Adults & Pupae	43	1	47	35.6
Total Number	120	3	132	
Total Taxa	8	2	8	
Number/1000 ft^3	7.9			
Number per M^3	2.2			
Cladocera				
Daphnia	647	100	1,047	
Terrestrial Volunteers	6	0	6	